Models coming soon to the SEP Scoreboard
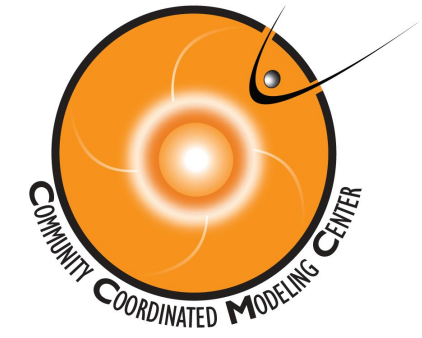
SEP Scoreboard Leads:
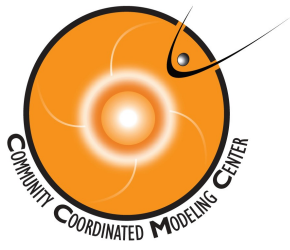
Mark Dierckxsens (BIRA-IASB)

Mike Marsh (UK Met Office)

Ian Richardson (NASA GSFC/UMD)

M. Leila Mays (CCMC)

CCMC community scoreboards

https://ccmc.gsfc.nasa.gov/challenges/

Leads**: Trinity College Dublin** (S. Murray), **ROB** (J. Adries)

Leads: **BIRA-IASB** (M. Dierckxsens, N. Crosby), **GSFC** (I. Richardson), **UK Met Office** (M. Marsh)

Leads: **CCMC** (L. Mays), **UK Met Office**

- Collecting and displaying event forecasts from multiple models into **Scoreboards**

- Fostering world-wide **community validation projects** that ultimately help researchers **improve** their CME, flare, and SEP forecasts and determine their **usefulness**.

- Allow a consistent **real-time** comparison of various operational and research forecasts. Complementary to non-real time model assessments.

- The flare and SEP scoreboards are **automated** such that model developers can routinely upload their predictions.

- Forecast data is parsed and stored in a **database** accessible to anyone via an **API**.
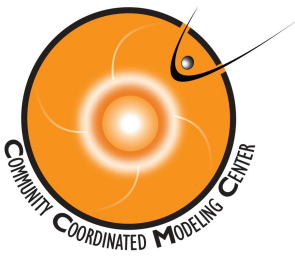
SEP Scoreboard

- Planning for the SEP Scoreboard has started (led by BIRA-IASB, GSFC, UK Met Office)

- Builds upon the flare scoreboard and CME arrival time scoreboard

- Automated system; model developers can routinely upload their predictions to an anonymous ftp. Forecast data will be parsed and stored in a database which accessible to anyone via an API

- SEP forecasts can be roughly divided into three categories:

Continuous/ Probabilistic   **Solar Event Triggered**   **Non Near Real-Time**

- The SEP scoreboard will focus on real-time forecasts (first and second categories) and will collect: proton flux profile, threshold crossing probability, onset time, and duration.

- The SEP scoreboard team will also coordinate with the SEP Working Team for historical comparisons, particularly for those physics-based models in the third category that are not ready or relevant for real-time modeling.

SEP Models in the Community and Literature *(compiled by Mike Marsh)*

Model Type	Model Name	Principal Developer(s)	Observational Inputs	Outputs
Empirial	AER SEP model	Lisa Winter (AER)	Type II, Type III, and Langmuir wave properties measured from Wind/WAVES	probability of a > 10 MeV proton event (> 10 pfu)
Empirial	AFRL PPS	Stephen Kahler (AFRL)	GOES x-ray peak flux & location	E>5 MeV intensities
Physics	EPREM	Nathan Schwadron (UNH)	Can be driven by in-situ proton observations, can be coupled with MHD	User defined flux range, also dose calculations within EMMREM framework
Physics	FLAMPA (SWMF)	University of Michigan	SWMF module coupled with MHD	
Empirical	FORSPEF	Anastasios Anastasiadis (NOA)	Magnetograms, x-ray flares	E > 30,60,100 MeV integral proton energy flux and fluence
Physics	Kota SEP (SWMF)	University of Michigan	SWMF module coupled with MHD	
Empirical	Laurenza model	Monica Laurenza (INAF)		
Physics	Luhmann Model	Janet Luhmann (UCB SSL)	Coupled with WSA-ENLIL+Cone (magnetograms, coronagraphs)	User defined flux range
Empirical	MAG4	David Falconer (NASA/MSFC, UAH)	Magnetograms, x-ray flares	24 hour event probabilistic forecast
Physics	PATH	Gary Zank, Gang Li (UAH)		
Physics & Empirical	PREDICCS	Nathan Schwadron (UNH)		(coupled version of EMMREM and REleASE)
Empirical	REleASE	Arik Posner	SOHO/COSTEP-EPHIN high energy electron flux. ACE/EPAM in new version	E=4-9, 9-16, 16-40, 28-50 MeV proton flux
Empirical	SEPForecast (COMESEP)	Mark Dierckxsens (BIRA IASB)	GOES x-ray peak flux & location, CME width & velocity, GLE observations	E>10 MeV and >60 MeV integral proton energy peak flux and probability
Physics	SOLPENCO	Angels Aran (Univ. Barcelona)	CME/Flare location & shock velocity estimate	User defined flux range
Physics	SPARX	Silvia Dalla (UCLan) Mike Marsh (UK Met Office)	Flare location, peak x-ray flux	User defined flux range
Empirical	SWPC PPM	Christopher Balch (NOAA/SWPC)	GOES x-ray, SEON radio burst, H-alpha/EUV imaging	E>10 MeV integral peak proton flux, peak time, and probability
Empirical	SWPC	NOAA/SWPC		Day 1-3 event probabilistic forecast
Empirical	UMASEP	Marlon Nuñez (Univ. Malaga)	Goes x-ray & proton fluxes	E>10 MeV integral proton flux. E>100 MeV proton flux in new version.
Empirical	UK Met Office	UK Met Office		Day 1-4 event probabilistic forecast
Physics	Zhang model	Ming Zhang (FIT)		

Continuous/Probabilistic

Continuous Probabilistic:

SWPC

UK Met Office

MAG4 (Falconer)

FORSPEF (NOA)

Continuous Profile:

PREDICCS (UNH)

Non Near Real-Time/Complex

CSWEPA MAS+EPREM
(PSI and UNH)
EPREM (UNH)
EPREM+cone (UNH)
EPREM+ENLIL (UNH + Odstricil)

iPATH (Li)
SEPMOD (Luhmann)
SPARX (Dalla, Marsh)
SWMF FLAMPA (UMich)
Zhang Model (FIT)

Solar Event Triggered

Flare and CME:

COMESEP SEPForecast

FORSPEF (NOA)

SOLPENCO (Arans)

Flare and proton flux:

UMASEP (Núñez)

CME:

Richardson SEP formula

St. Cyr (Mauna Loa CME)

Electron flux:

REleASE

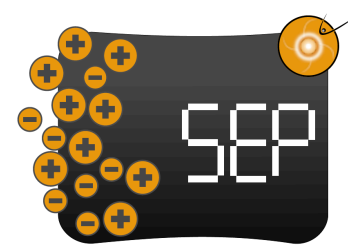Flare, Radio, H-alpha:

SWPC PPM

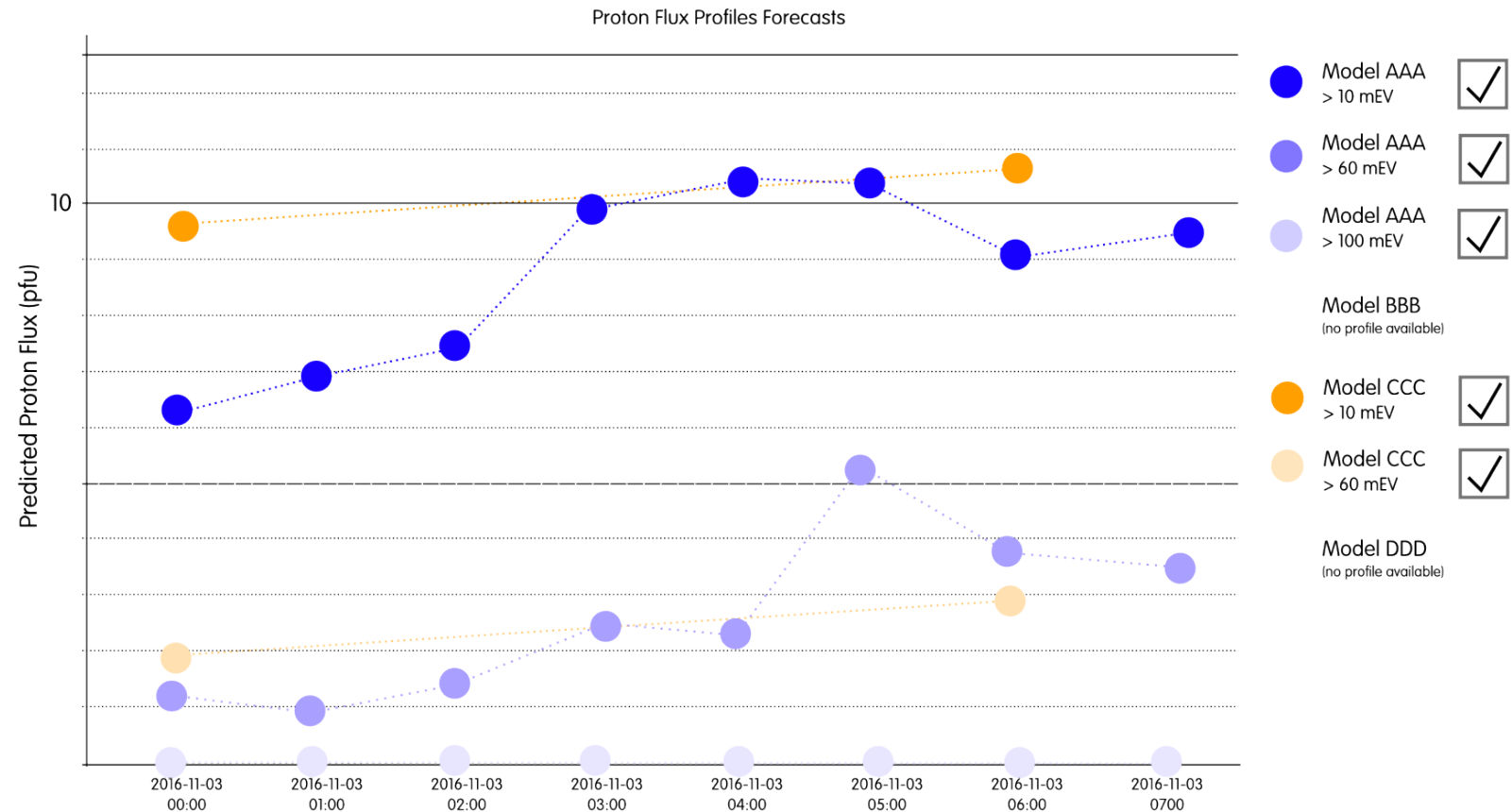Flare, Radio:
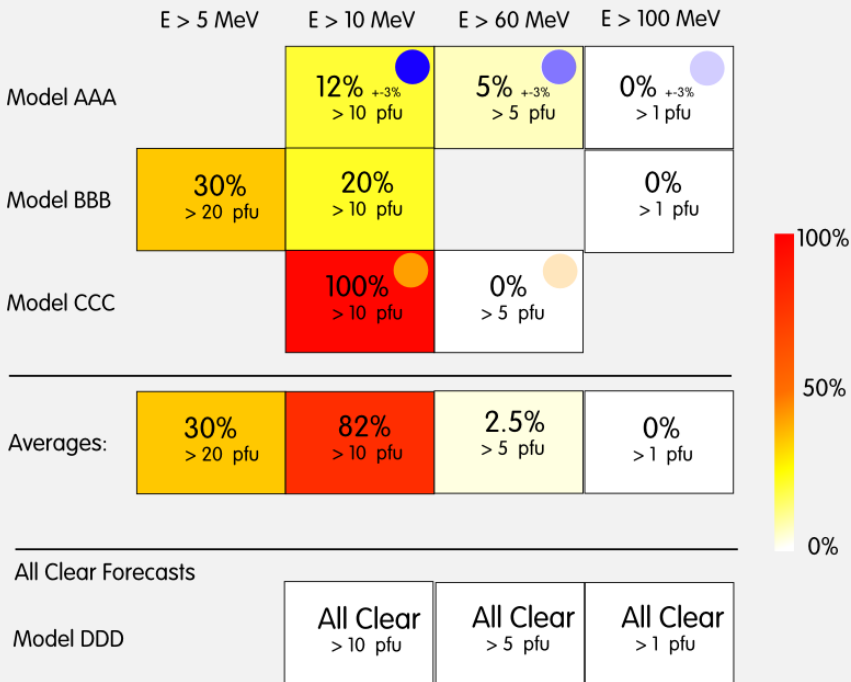
Laurenza Model

Radio:

AER SEP Model (Winter)

Flare:

AFRL PPS

COMESEP SEPForecast (BIRA)

FORSPEF (NOA)

SPARX (Dalla, Marsh)

Bolded models have already confirmed participation in the SEP scoreboard

Forecasts: 2016-11-03 00:00 + 24 hours

Proton Flux Profiles Forecasts

Probability heat map at a single time

https://ccmc.gsfc.nasa.gov/challenges/sep.php

Predicted proton flux time-series

Relevant SHINE Workshop sessions:
SEP Models in the Community
(SHINE: July 30—August 3, 2018)

Sessions:

Coupled heliospheric and solar energetic particle models
Organizers: Christina Lee (UC Berkeley), Janet Luhmann (UC Berkeley), M. Leila Mays (NASA/GSFC)

Predicting solar energetic particles: community campaign
Organizers: M. Leila Mays (NASA GSFC), Hazel Bain (NOAA SWPC), Ian Richardson (UMD/NASA GSFC)

Is Understanding Magnetic Field Connectivity Crucial for Understanding Solar Energetic Particle Events?
Organizers: Hazel Bain (NOAA SWPC), Ian Richardson (University of Maryland/GSFC)

Coupled heliospheric and solar energetic particle models

Organizers: Christina Lee (UC Berkeley), Janet Luhmann (UC Berkeley), M. Leila Mays (NASA/GSFC)

SHINE Session summary:

There have been efforts in the community to **couple SEP models (EPREM, iPATH, SEPMOD, SWMF FLAMPA) with heliospheric models (ENLIL, MAS, SWMF, ZEUS-3D),** each with their own challenges and advantages. There are also a number of modelers that are interested in coupling helio and SEP models, but need to **learn more about model outputs and input requirements**. Some SEP models use the full 3D MHD output from the heliospheric models, while others use a derived post-processed subset. Some include the coronal portion of the CME/ICME including the ejecta and/or any shock that forms below a few 10s of solar radii, and others do not. Each model has its own assumptions regarding the SEP source(s) and transport and uses (or couples with) the helio MHD model results differently. **In this session we aim to discuss what we have learned from our experiences so far and how to better coordinate future efforts.**

We will address the following questions:

1) What are the main issues with coupling heliospheric and SEP models (including helio model issues that affect the SEP model results)?

2) What have we already learned from attempts to couple heliospheric and SEP models, and what new information could/should we draw from them?

Predicting solar energetic particles: community campaign

Organizers: M. Leila Mays (NASA GSFC), Hazel Bain (NOAA SWPC), Ian Richardson (UMD/NASA GSFC)

SHINE Session summary:

There are now nearly 20 physics-based or empirical SEP models created by the community, but how well do these models predict SEP events throughout the heliosphere? In the literature, most physics-based models focus on event studies, while empirical models take a statistical approach to build and validate their models. **Future performance benchmarks may be established for physics-based models in a systematic, controlled way and for much longer time periods.** But as a first step towards this goal, **we invite the SEP modeling community to examine two case study campaign periods (defined below) and briefly present their results in the session.** We also ask modelers to address the following questions when showing their results: How did your optimized run results differ from the initial run? What aspects of the event does your model capture well, and what aspects were more difficult to capture? What are the next steps for your modeling technique? Modelers using both physics-based and empirical models are encouraged to participate. We also wish to highlight the CCMC SEP Scoreboard (https://ccmc.gsfc.nasa.gov/challenges/sep.php) which provides a forum for comparing SEP predictions for future and past events.

The following questions will also be discussed:
1) How successfully can the SEP modeling community characterize these SEP campaign events overall?
2) Do differences in model assumptions or model types lead to different predictions?
3) What are the difficulties associated with modeling these two events, and SEP modeling in general?